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COMMERCIAL DEMONSTRATION OF THE NOXSO SO_2/NO_x REMOVAL FLUE GAS CLEANUP SYSTEM

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Project Definition Phase

U.S. DOE Patent Clearance Is Not Required Prior to the Publication of this Document

DISCLAIMER

Prepared by

Morrison Knudsen Corporation
Ferguson Division
1500 West 3rd Street
Cleveland, Ohio 44113-1406

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1.0 INTRODUCTION

The NOXSO Process is a dry, post-combustion flue gas treatment technology which uses a regenerable sorbent to simultaneously adsorb sulfur dioxide (SO_2) and nitrogen oxides (NO_x) from the flue gas of a coal-fired utility boiler. In the process, the SO_2 is reduced to elemental sulfur and the NO_x is reduced to nitrogen and oxygen. It is predicted that the process can economically remove 90% of the acid rain precursor gases from the flue gas stream in a retrofit or new facility.

Details of the NOXSO Process are described with the aid of Figure 1. Flue gas from the power plant is drawn through a flue gas booster fan which forces the air through the fluid bed adsorber and centrifugal separator before passing to the power plant stack. Water is sprayed into the flue gas as required to lower the temperature by evaporative cooling. The fluid bed adsorber contains active NOXSO sorbent. The NOXSO sorbent is a 1.6 mm diameter γ-alumina bead impregnated with 5.2 weight % sodium. The centrifugal separator separates sorbent which may be entrained in the flue gas and returns it back to the adsorber.

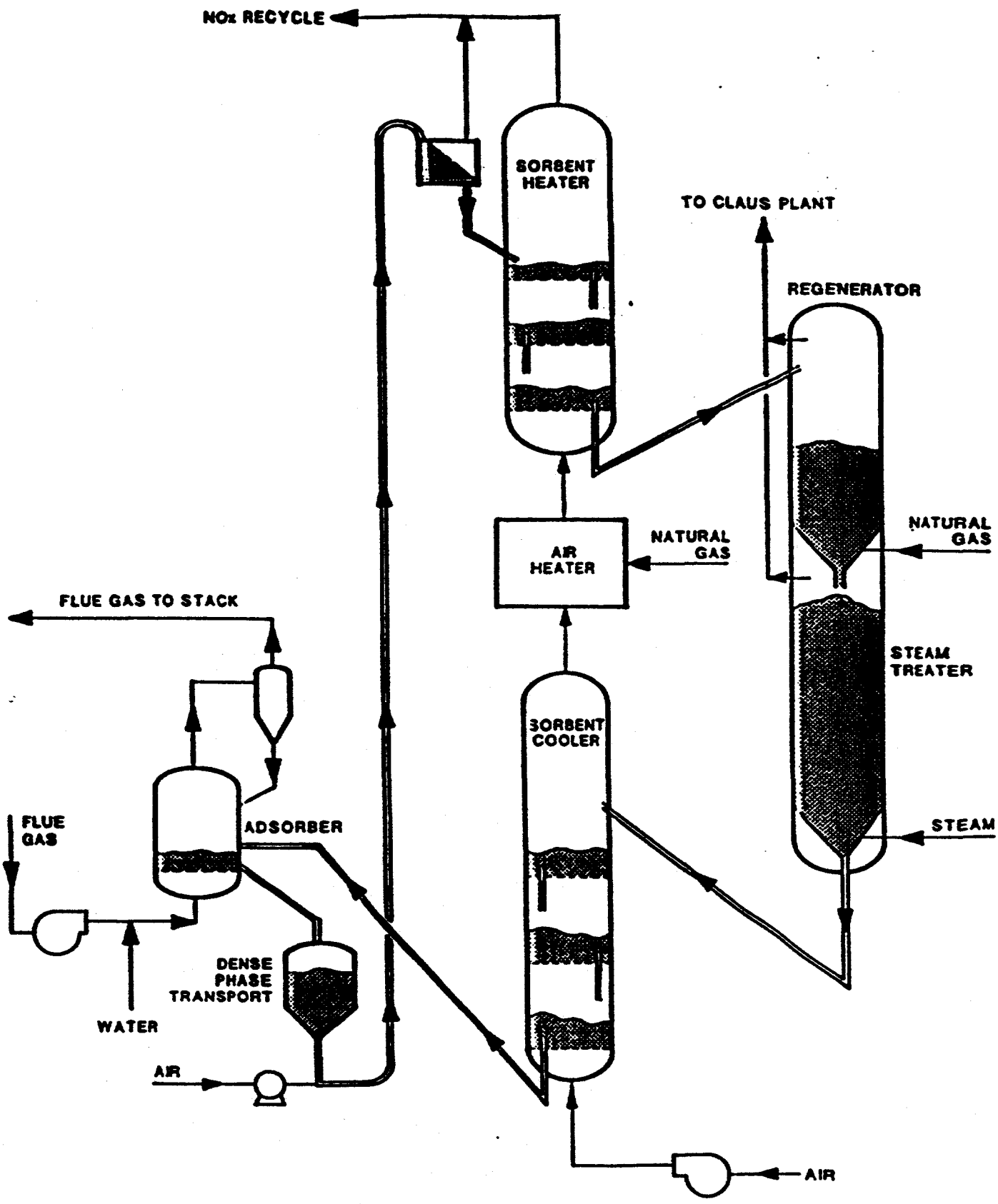
Spent sorbent from the adsorber flows into a dense-phase conveying system which lifts the sorbent to a disengaging vessel. From the disengaging vessel the sorbent flows by gravity to the top bed of the sorbent heater. The sorbent flows through the multi-stage fluidized bed sorbent heater counter to the heating gas which heats the sorbent to the regeneration temperature of approximately 1200°F.

In the process of heating the sorbent, the NO_x is driven from the sorbent and carried to the power plant boiler in the NO_x recycle stream. The NO_x recycle replaces a portion of the combustion air. The presence of NO_x in the combustion air reduces the formation of NO_x in the boiler resulting in a net destruction of NO_x.

The heated sorbent enters the regenerator where it is contacted with a methane reducing gas. Through a series of chemical reactions, the sulfur on the sorbent combines with the methane and forms SO_2 and H_2S. Additional regeneration occurs in the steam treater when the sorbent is contacted with steam converting the remaining sulfur on the sorbent to H_2S.

The regenerator and steam treater off-gas streams are combined and directed to a Claus plant where the H_2S and SO_2 are converted to liquid elemental sulfur. Tail gas from the sulfur plant will be incinerated and recycled back through the adsorbers to remove any sulfur compounds.

High temperature sorbent exiting the steam treater passes to the multi-stage fluidized bed sorbent cooler. The sorbent flows counter to the ambient air which cools the sorbent. Regenerated sorbent exits the cooler at 250°F. It is directed to the adsorber completing the sorbent cycle.



NOXSO PROCESS FLOW DIAGRAM

FIGURE 1

Ambient air which is forced through the sorbent cooler by the heater-cooler fan exits the sorbent cooler at approximately 800°F. This preheated air then enters the air heater where it is heated to approximately 1350°F so it is capable of heating the sorbent exiting the sorbent heater to 1200°F.

2.0 PROJECT DESCRIPTION

The objective of the NOXSO Demonstration Project is to design, construct, and operate a flue gas treatment system utilizing the NOXSO Process at Ohio Edison's Niles Plant Unit #1. The effectiveness of the process will be demonstrated by achieving significant reductions in emissions of sulfur and nitrogen oxides. In addition, sufficient operating data will be obtained to confirm the process economics and provide a basis to guarantee performance on a commercial scale. Ohio Edison's Niles Plant Unit #1 generates 115 MW of electricity and 275,000 scfm of flue gas while burning 3.5% sulfur coal.

3.0 PROJECT STATUS

The project is presently in the project definition and preliminary design phase. This phase was included in the project to allow completion of process studies and preliminary activities which could be conducted in parallel with NOXSO's pilot plant project being conducted at Ohio Edison's Toronto Power Plant.

NEPA Compliance

No NEPA compliance activities were conducted this reporting period.

Preliminary Engineering

No preliminary engineering activities were conducted during this reporting period.

Nitrogen Oxide Studies

Although "An Experimental Study of NO_x Recycle in the NOXSO Flue Gas Cleanup Process", DOE contract DE-AC22-91PC91337, is not technically a part of this project, the results are essential to this projects success. Detailed results are available in the quarterly report for the project, however a summary is presented here.

The small boiler simulator (SBS) at B&W was modified to support this project including installation of a NO_x injection and measurement system. This allows injection of NO_x into the primary or secondary combustion air and measurement of the NO_x concentration as required. Shakedown and baseline tests were conducted. Coal from the same source which supplies coal for the Niles plant was obtained and analyzed.

A NO_x material balance was conducted by injecting NO_x with the combustion air (without combustion in the furnace) while measuring flowrates and NO_x concentration in the combustion air ducts and the boiler stack. The material balance closed between 92% to 95%.

The tests of NO injection with combustion have demonstrated very promising results. The test data showed quite consistent NO_x reduction efficiencies, which is similar to the previous test results on the pulverized coal combustor at DOE-PETC. An average of about 70% NO_x destruction efficiency was achieved for the NO injection into the primary air duct and is independent of injected NO flowrates and exit O_2 concentrations. About 58%, 50%, and 46% average destruction efficiencies were obtained for the NO injection into the secondary air duct corresponding to the exit O_2 concentrations of 2%, 3%, and 4% respectively.

Process Studies

No process studies specifically associated with the demonstration plant design were conducted during this reporting period. The NOXSO Proof-of-Concept (POC) plant was operated on flue gas for approximately 350 hours during this reporting period. A couple of problems were identified and resolved during this time period. These included:

- Sorbent heater grid pluggage

The problem was solved by countersinking the holes from the bottom. The holes in the middle grid were enlarged from 1/8" to 5/32" diameter. A permanent solution to the problem for the demonstration plant is to space the fluid bed grids farther apart. The sorbent cooler, with grid spacings of 66 inches has experienced no plugging problems. Conversely, the sorbent heater with 44 inch grid spacing required the modification described above.

- Incinerator trips on low flame signal

The incinerator UV flame scanner was replaced with an IR scanner. H_2O in the gas feed to the incinerator absorbed some UV resulting in weak flame signals. Also, sulfur deposits periodically blocked the flame scanner window. Modifications to the flame scanner installation resolved this problem. The incinerator at the POC takes the place of the sulfur plant for the demonstration. Although, an incinerator will be included as the last process unit in the sulfur plant, no problems are anticipated.

A design has been prepared and equipment purchased to install a natural gas reformer at the POC. The reformed gas will be used in place of the natural gas as the reducing gas for sorbent regeneration. Laboratory tests indicate the regeneration can be accomplished at a lower temperature using reformed natural gas.

Plant Characterization

No effort was made to obtain power plant characterization information during this period.

Site Survey/Geotechnical Investigation

No site survey was conducted or geotechnical investigation obtained during this period.

Permitting

No permitting activities were conducted during this reporting period.

4.0 SUMMARY

Activity on this project has been minimal while awaiting results from the NOXSO pilot plant. Staffing and expenditures reflect this low level of effort.